

REMARKS

Claims 20, 25, and 26 are canceled without prejudice, claims 37 to 40 are added without prejudice, and claims 19, 21 to 24 and 27 to 40 are now pending.

It is respectfully submitted that all of the presently pending claims are allowable, and reconsideration is therefore respectfully requested.

As to paragraph three (3) of the Office Action, claims 19 to 22 and 24 to 27 were rejected under 35 U.S.C. § 103(a) as unpatentable over the Flamm reference in view of Pu et al., U.S. Patent No. 5,843,847.

While the rejections may not be agreed with (see, for example, Appeal Brief), to facilitate matters, claim 19 as presented is directed to a method of anisotropic plasma etching a laterally defined structure in a silicon substrate using a process gas, and now includes the feature of claim 20 (which has been canceled). It is noted that SiF_4 and the last three compounds C_4F_{10} , C_3F_8 and C_2F_6 have been deleted from the list. The addition of compounds C_4F_8 and/or C_3F_6 is not disclosed or suggested by “Flamm” (nor “Sony”). It is also believed and respectfully submitted that the addition of the mentioned gases in claim 19 as presented, as compared to the addition of C_2F_6 in “Flamm”, would not be obvious to a person having ordinary skill in the art, since the C_2F_6 of “Flamm” is a chemically saturated compound, while the gases C_4F_8 and/or C_3F_6 of claim 19 as presented are non-saturated compounds, and are therefore especially suited as a passivating gas.

It is therefore respectfully submitted that claim 19 as presented is allowable for the above reasons as to the primary and secondary references (as well as to the “Charlet” reference).

Accordingly, claim 19 is allowable, as are its dependent claims 21 and 22 (claim 20 has been canceled without prejudice, since its features have been included in claim 19 as presented; it is noted that Argon and Nitrogen have been deleted from claim 21, so that it only includes oxygen and compounds thereof).

Claim 24 as presented includes features like that of claim 19 as presented, so that claim 24 as presented is allowable for essentially the same reasons as claim 19 as presented.

Claims 25 and 26 have been canceled without prejudice, since their features have in part been included in claim 24 as presented.

Claim 27 depends from claim 24 as presented and is therefore allowable for the same

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reasons as claim 24 as presented. (It is noted that as with claim 21, Argon and Nitrogen have been deleted from claim 27 as presented, as with claim 21).

Accordingly, in view of the foregoing, claims 19, 21, 22, 24 and 27 are allowable (claims 20, 25 and 26 having been canceled without prejudice).

As to paragraph four (4) of the Office Action, claims 23 and 28 to 36 were rejected as unpatentable over Flamm in view of “Pu”, as applied to claims 19 to 22 and 24 to 27, and in further view of U.S. Patent No. 5,047,115 (“Charlet”).

Claims 23 and 28 respectively depend from claim 19 as presented and claim 24 as presented, and are therefore allowable for the same reasons as claim 19 as presented and claim 24 as presented, respectively, as explained above. It is noted that the “Charlet” reference was addressed above.

Claim 29 has been revised to better claim the subject matter of that claim. The former provision of claim 29 that the gas is at least one of helium, hydrogen or neon is now provided in its new dependent claim 39. Accordingly, claim 29 is allowable since it provides for *adding a light, easily ionizable gas to the process gas to at least one of improve selectivity, reduce charging effects, increase separation between light ions and heavy ions, and reduce or suppress stray trench fields*. In short, claim 29 is allowable since its use of such a gas provides the benefits described below, since these benefits are not provided for by the “Charlet” reference, and since the “Charlet” reference teaches away from the use of a light, easily ionizable gas, as provided for in the context of claim 29.

In particular, claim 29 provides, in part, for “*adding a light, easily ionizable gas to the process gas to at least one of improve selectivity, reduce charging effects, increase separation between light ions and heavy ions, and reduce or suppress stray trench fields*”.

The added features and their benefits are supported in the present application, as follows:

Addition of a light and easily ionizable gas, i.e., of a gas with a low atomic mass such as He, H₂, or Ne, from which slightly positively charged ions are obtained, to the etching gas has the advantage that charging effects, which manifest themselves as interference, in particular at the junctions between electrically conductive silicon and electrically insulating dielectric materials used, for example, as masking materials or buried sacrificial layers, are considerably reduced. Thus considerable improvement in the etching profiles are obtained is achieved, in particular at the junction of silicon with a buried oxide layer, a polymer stop layer, or at the mask edge, i.e., junction of the dielectric masking layer (photoresist or hard material mask made of SiO₂)

with the silicon to be etched.

This charging effect is based on the fact that negatively charged electrons, which act upon the wafer surface anisotropically, go preferentially to the side walls of the structure to be etched, so that the side walls become negatively charged with respect to the etching base. These electrons move relatively freely within the electrically conductive silicon, while the positively charged ions on the electrically insulating etching base are stationary. Thus, the movable electrons tend to move into the junction region between silicon and the dielectric material, generating a strong electric field there. In the steady-state case these fields on average result in exactly as many ions going to the side walls as there were electrons previously, since they are deflected by the electric fields of a similar strength toward the side wall. This effect is described in the literature as the "notching phenomenon" and results in the formation of large pockets etched into the side wall.

The addition of a light, easily ionizable gas such as He advantageously reduces this formation of pockets considerably.

Another problem caused by electrical charging effects, which is also eliminated by the addition of a light, easily ionizable gas, occurs at the upper mask edge. The surface of a dielectric masking layer on the silicon wafer is negatively charged ("DC bias") by the "self-biasing" effect, often as a result of a high-frequency voltage applied to a conventional substrate electrode. This charge is caused by the different mobilities of electrons and ions, i.e., in order to draw as many immobile ions as highly mobile electrons to the surface on average over time, a negative electrical bias must be built up there. If silicon is now etched in the openings of a masking layer, this accumulation of surface charges with respect to the newly produced silicon side wall results in concentration of electrons at the silicon to dielectric masking layer junction. Therefore ions are increasingly deflected into this upper part of the etched silicon trench, which also results in the formation of profile irregularities or pockets there. Finally, ***the addition of a light, easily ionizable gas to the etching gas has the advantage that*** the side wall film transport mechanism [of] German Patent 42 41 045 is improved in that more polymer is stripped from the etching base and less from the side walls, i.e., ***selectivity is improved.***

....

In the mechanisms described above, overall the intensity of the electrical fields required to establish the dynamic equilibrium between the incidence of ions and electrons directly depends on the ease with which the arriving ions can be deflected by electrical fields. [R]elatively heavy ions are only deflected by relatively high-intensity fields, while relatively light ions can be deflected even by relatively low-intensity fields, balancing the charges. By introducing a type

of ion with a low atomic mass, it can be achieved to great advantage that only low field intensities are built up in the above-described regions and a sufficient number of these light ions is deflected even with these low field intensities so that they can balance the charges.

The heavy ions occurring in the etching process, for example, as ionized molecules or molecule fragments of the etching gas or additives are no longer deflected by these electrical fields due to their mass and associated inertia, but go directly to the etching base, where they can advantageously promote an etching reaction or etching base polymer stripping, for example. *Therefore, the addition of the light, easily ionizable gas results in separation, which is overall very advantageous, between light ions, which balance the charges, and heavy ions, which . . . affect the etching base.*

In addition to the inert gas helium as a light gas, the use of hydrogen (H_2) is also advantageous in some plasma etching processes, as long as it is compatible with the process chemistry. . . .

. . . .

[The above method] is improved . . . by the fact that helium in the form of He^4 or He^3 is also added to the process gas at least from time to time, this addition taking place continuously both during the etching steps and during the passivation steps, since helium as an inert gas in no way affects the process chemistry. *The addition of helium guarantees in both steps that undesirable charges are reduced and harmful ion incidence onto the side walls of the etched structures, as explained above, is permanently suppressed or reduced.*

As an alternative, the helium gas can, however, also take place only during the etching steps or only during the polymerization/passivation steps, i.e., the helium flow is added at determined intervals like the etching and passivating gas, helium gas advantageously being used specifically during the etching steps, since, especially in the case of post-etching, buildup of stronger stray fields in the trenches formed must be effectively suppressed even as they are generated. Helium is preferably added in both process steps continuously at a constant gas flow rate.

. . . .

Finally, selectivity between side wall polymer film stripping and etching base polymer stripping during the etching steps is also improved by the process gas addition . . . , in particular by addition of He or H_2 , in that etching base polymer stripping is accelerated and side wall polymer film stripping is reduced. This is one result of the preferred deflection of the lighter ions toward the side wall, while heavy ions reach the etching base unimpeded.

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The addition of light and easily ionizable gases such as H₂, Ne or . . . He is more effective the lower the frequency of the substrate electrode voltage at the substrate electrode, since the lighter ions can follow the variation of the electrical field more easily due to their lower inertia. . . .

In the above exemplary embodiment, the frequency of the high-frequency substrate voltage used is reduced for this purpose, for example, from the usual 13.56 MHz to less than 2 MHz. Thus the difference in mass between the lighter gas component and the other components of the etching gas is used to greater advantage.

(Specification, pages 7, 11, 16, 17). None of the references (including the “Charlet” reference, U.S. Patent No. 5,047,115 discussed below) in any way disclose the features of claim 29 as presented, and the benefits provided by those features, as explained above (and as essentially admitted in the Office Action).

As to the “Charlet” reference, it only states at columns 2 and 3 that:

The rare gases which can be used can e.g. be helium, argon, neon and krypton. The rare gas or mixture of rare gases used ensures the stability of the discharge and its extension to the substrate.

Thus the disassociation of a rare gas leads to ionized and neutral species with a long life, which makes it possible to maintain for a certain time the discharges caused by the ultra-high frequency waves In general, use is made of argon or a mixture of argon and helium.

Even if it were proper to combine the “Charlet” reference with the primary and secondary references (which is not conceded), claim 29 as presented provides for a light, easily ionizable gas as provided for in the context of the claim to provide various benefits, as explained above, so that claim 29 is allowable.

Claims 30 to 33 depend from claim 29 and are therefore allowable for the same reasons as claim 29. As to claim 32, it has been revised like claim 21, so that it does not recite Argon or Nitrogen, as previously provided for.

To better claim its subject matter, claim 34 as presented includes features like that of claim 29 as presented, and is therefore allowable for essentially the same reasons as claim 29, since its use of these gases provide the benefits described above as to claim 29, since these benefits are not provided for by the “Charlet” reference, and since the “Charlet” reference

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teaches away from the use of a light, easily ionizable gas because as explained above, so that claim 34 as presented is allowable.

Claims 35 and 36 depend from claim 34 and are therefore allowable for the same reasons as claim 34. As to claim 36, it has been revised like claim 21, so that it does not recite Argon or Nitrogen, as previously provided for.

As to paragraph five (5) of the Office Action, claims 19 to 21 were rejected as unpatentable over Sony, EP 0 414 372 A2.

As to claim 19 as presented, it is allowable for essentially the same reasons as explained above, since claim 19 as presented is directed to a method of anisotropic plasma etching a laterally defined structure in a silicon substrate using a process gas, and now includes the feature of claim 20 (which has been canceled). It is noted that SiF_4 and the last three compounds C_4F_{10} , C_3F_8 and C_2F_6 have been deleted from the list. The addition of compounds C_4F_8 and/or C_3F_6 is not disclosed or suggested by "Sony" (nor "Flamm"), as explained above. It is also believed and respectfully submitted that the addition of C_4F_8 and/or C_3F_6 in claim 19 as presented, as compared to the addition of C_2F_6 , for example, would not be obvious to a person having ordinary skill in the art, since C_2F_6 is a chemically saturated compound, while the gases C_4F_8 and/or C_3F_6 of claim 19 as presented are non-saturated compounds, and are therefore especially suited as a passivating gas.

Thus, while the rejections may not be agreed with, to facilitate matters, claim 19 has been rewritten to better clarify the claimed subject matter, and is therefore allowable over the "Sony" reference for the above reasons.

Claim 21 depends from claim 19 as presented, and are therefore allowable for the same reasons as claim 19 as presented. Claim 20 has been canceled without prejudice, since its features have been included in claim 19 as presented.

As to paragraph six (6) of the Office Action, claims 23, 29 to 32 and 34 to 36 were rejected as unpatentable over "Sony", as applied to claims 19 to 21, and in further view of U.S. Patent No. 5,047,115 ("Charlet").

Claim 23 depends from claim 19 as presented, and is therefore allowable for essentially the same reasons as claim 19 as presented, since as explained above the third-level "Charlet" reference does not disclose or suggest the benefits and features of claim 19 as presented.

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Claim 29 as presented is allowable for essentially the same reasons as explained above, since its use of a light, easily ionizable gas, as provided for in the context of the claim, provide the benefits described above, since these benefits are not provided for by the primary reference or the secondary “Charlet” reference, and since the secondary “Charlet” reference teaches away from the use of a light, easily ionizable gas for the reasons provided above.

Claims 30 to 32 depend from claim 29 and are therefore allowable for the same reasons as claim 29.

As explained above, claim 34 has been revised to better claim the subject matter of that claim. The former provision of claim 34 that the gas is at least one of helium, hydrogen or neon is now provided in new dependent claim 40. Accordingly, claim 34 is allowable since it provides for *adding a light, easily ionizable gas to the process gas to at least one of improve selectivity, reduce charging effects, increase separation between light ions and heavy ions, and reduce or suppress stray trench fields*. Accordingly, claim 34 is allowable for essentially the same reasons as claim 29, since its use of such a gas provides the benefits described below, since these benefits are not provided for by the “Charlet” reference, and since the “Charlet” reference teaches away from the use of a light, easily ionizable gas, as provided for in the context of the claim.

Claims 35 and 36 depend from claim 34 and are therefore allowable for the same reasons as claim 34.

As further regards the obviousness rejections, to reject a claim under 35 U.S.C. § 103(a), the Office bears the initial burden of presenting a prima facie case of obviousness. In re Rijckaert, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). To establish prima facie obviousness, three criteria must be satisfied. First, there must be some suggestion or motivation to modify or combine reference teachings. In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). This teaching or suggestion to make the claimed combination must be found in the prior art and not based on the application disclosure. In re Vaeck, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Second, there must be a reasonable expectation of success. In re Merck & Co., Inc., 800 F.2d 1091, 231 U.S.P.Q. 375 (Fed. Cir. 1986). Third, the prior art reference(s) must teach or suggest all of the claim features. In re Royka, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974). Since the references relied upon do not disclose or even suggest all of the features of the independent claims as

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presented (or their dependent claims) as explained above, it is respectfully submitted that all of the independent claims are allowable, as are their respective dependent claims, as explained above.

It is respectfully submitted that the cases of In re Fine, supra, and In re Jones, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992), make plain that the Office Action's generalized assertions that it would have been obvious to modify the reference do not properly support a § 103 rejection. It is respectfully submitted that those cases make plain that the Office Action reflects a subjective "obvious to try" standard, and therefore does not reflect the proper evidence to support an obviousness rejection based on the references relied upon. In particular, the Court in the case of In re Fine stated that:

The PTO has the burden under section 103 to establish a *prima facie* case of obviousness. It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. This it has not done. . . .

Instead, the Examiner relies on hindsight in reaching his obviousness determination. . . . One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.

In re Fine, 5 U.S.P.Q.2d at 1598 to 1600 (citations omitted; italics in original; emphasis added). Likewise, the Court in the case of In re Jones stated that:

Before the PTO may combine the disclosures of two or more prior art references in order to establish *prima facie* obviousness, there must be some suggestion for doing so, found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. . . .

Conspicuously missing from this record is any evidence, other than the PTO's speculation (if it be called evidence) that one of ordinary skill . . . would have been motivated to make the modifications . . . necessary to arrive at the claimed [subject matter].

In re Jones, 21 U.S.P.Q.2d at 1943, 1944 (citations omitted; italics in original).

That is exactly the case here since it is believed and respectfully submitted that the Office Action offers no evidence whatsoever, but only conclusory hindsight, reconstruction

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and speculation, which these cases have indicated does not constitute evidence that will support a proper obviousness finding. Unsupported assertions are not evidence as to why a person having ordinary skill in the art would be motivated to modify or combine references to provide the claimed subject matter of the claims to address the problems met thereby. Accordingly, the Office must provide proper evidence of a motivation for modifying or combining the references to provide the claimed subject matter.

More recently, the Federal Circuit in the case of In re Kotzab has made plain that even if a claim concerns a “technologically simple concept” -- which is not the case here -- there still must be some finding as to the “specific understanding or principle within the knowledge of a skilled artisan” that would motivate a person having no knowledge of the claimed subject matter to “make the combination in the manner claimed,” stating that:

In this case, the Examiner and the Board fell into the hindsight trap. The idea of a single sensor controlling multiple valves, as opposed to multiple sensors controlling multiple valves, is a technologically simple concept. With this simple concept in mind, the Patent and Trademark Office found prior art statements that in the abstract appeared to suggest the claimed limitation. But, there was no finding as to the specific understanding or principle within the knowledge of a skilled artisan that would have motivated one with no knowledge of Kotzab's invention to make the combination in the manner claimed. In light of our holding of the absence of a motivation to combine the teachings in Evans, we conclude that the Board did not make out a proper prima facie case of obviousness in rejecting [the] claims . . . under 35 U.S.C. Section 103(a) over Evans.

In re Kotzab, 55 U.S.P.Q.2d 1313, 1318 (Fed. Cir. 2000) (emphasis added). Again, it is believed that there have been no such findings.

More recent still, in the case of In re Lee, 61 U.S.P.Q.2d 1430, 1433-35 (Fed. Cir. 2002), the Court reversed the Board of Appeals for relying on conclusory statements, stating the following:

With respect to Lee's application, neither the examiner nor the Board adequately supported the selection and combination of the Nortrup and Thunderchopper references to render obvious that which Lee described. The examiner's conclusory statements that “the demonstration mode is just a programmable feature which can be used in many different device[s] for providing automatic introduction by adding the

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*proper programming software” and that “another motivation would be that the automatic demonstration mode is user friendly and it functions as a tutorial” do not adequately address the issue of motivation to combine. **This factual question of motivation is material to patentability, and could not be resolved on subjective belief and unknown authority.*** It is improper, in determining whether a person of ordinary skill would have been led to this combination of references, simply to “[use] that which the inventor taught against its teacher.” Thus the Board must not only assure that the requisite findings are made, based on evidence of record, but must also explain the reasoning by which the findings are deemed to support the agency's conclusion.

....

*In its decision on Lee's patent application, the Board rejected the need for “any specific hint or suggestion in a particular reference” to support the combination of the Nortrup and Thunderchopper references. **Omission of a relevant factor required by precedent is both legal error and arbitrary agency action.***

*[The] “common knowledge and common sense” on which the Board relied in rejecting Lee's application are not the specialized knowledge and expertise contemplated by the Administrative Procedure Act. **Conclusory statements such as those here provided do not fulfill the agency's obligation.*** [The] Board's findings must extend to all material facts and must be documented on the record, lest the “haze of so-called expertise” acquire insulation from accountability. “Common knowledge and common sense,” even if assumed to derive from the agency's expertise, do not substitute for authority when the law requires authority.

Accordingly, claims 19, 21 to 24 and 27 to 36 are allowable for the above reasons.

New claims 37 to 40 do not add any new matter and are supported in the specification. New claim 37 is like claim 19 up until the feature, “consisting of ClF_3 , BrF_3 and IF_3 ”, the addition of SiF_4 now being provided as a passivating gas together with the features of claim 21 as presented (namely, the addition of oxygen and compounds thereof) being included. Regarding the addition of compounds including oxygen, from the cited references only CF_4/O_2 , SF_6/O_2 or $\text{C}_2\text{F}_6/\text{O}_2$ (“Flamm”) and Cl_2/O_2 or SiCl_4/O_2 (“Sony”) are referred to, none of

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which are the compounds of claim 37, so that claim 37 is allowable.

New claim 38 corresponds to claim 24 as presented up until the feature, “consisting of SF₆, ClF₃ and BrF₃ and IF₅”, the addition of SiF₄ now being provided as a passivating gas together with the features of claim 27 as presented (namely, the addition of oxygen and compounds thereof) being included. Regarding the addition of compounds including oxygen, from the cited references only CF₄/O₂, SF₆O₂ or C₂F₆/O₂ (“Flamm”) and Cl₂/O₂ or SiCl₄/O₂ (“Sony”) are referred to, none of which are the compounds of claim 38, so that claim 38 is allowable.

New claim 39 depends from claim 29, and is therefore allowable for the same reasons as claim 29. Still further, the krypton and argon gases of the references relied upon are substantially heavier than the light, easily ionizable gases provided for by claim 39, including hydrogen, helium and neon. It is noted that the atomic weight of Argon is four times that of Neon and ten times that of Helium, and the atomic weight of Krypton is about eight times that of Neon and twenty times that of Helium, so that it is believed and respectfully submitted that the third-level “Charlet” reference teaches away from the claimed subject matter and its benefits, so that claim 39 is allowable for this further reason.

New claim 40 depends from claim 34, and is therefore allowable for the same reasons as claim 34. Still further, the krypton and argon gases of the references relied upon are substantially heavier than the light, easily ionizable gases provided for by claim 40, including hydrogen, helium and neon. It is noted that the atomic weight of Argon is four times that of Neon and ten times that of Helium, and the atomic weight of Krypton is about eight times that of Neon and twenty times that of Helium, so that it is believed and respectfully submitted that the third-level “Charlet” reference teaches away from the claimed subject matter and its benefits, so that claim 40 is allowable for this further reason.

Accordingly, claims 19, 21 to 24 and 27 to 40 are allowable for all of the above reasons.

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CONCLUSION

In view of the foregoing, it is believed that the rejections have been obviated, and that currently pending claims 19, 21 to 24 and 27 to 40 are allowable. It is therefore respectfully requested that the rejections be withdrawn, and that the present application issue as early as possible.

Respectfully submitted,
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